A Prototype Bayesian Precipitation Retrieval Algorithm Over Land for ATMS

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Background

- We have developed a prototype precipitation algorithm by considering both surface condition and precipitation vertical structure.
- Results from SSMIS (imager) based on this prototype algorithm greatly outperform the traditional single database algorithm.
- This prototype algorithm is applied to ATMS (sounder).
- This work has been done in **the NASA GPM retrieval algorithm framework**, and has the potential to be applied to all GPM constellation radiometers, particularly the sounders (e.g., ATMS and AMSU)

Method for precipitation detection and retrieval

- The Linear Discriminant Analysis (LDA) is used for precipitation (rainfall/snowfall) detection.
- The Bayesian algorithm based on the Principal Component Analysis (PCA) is employed for precipitation retrieval.
- The PCA is applied to TBs, corresponding to same surface rainrate, which guarantee that the covariance matrix is diagonal.

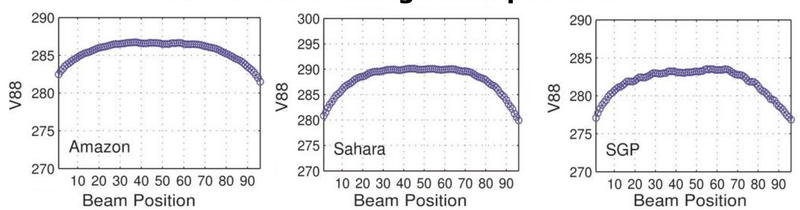
Database construction

- NMQ ground radar observations with radar quality index greater than 0.5
- ATMS 13 TBs from 19 GHz to 191 GHz
- Data from 11/2011 to 12/2013 over continental US (CONUS) as training
- Applied this database over CONUS and globally over land for 2014

Database stratification

- We have showed that using the following four parameters to stratify the single database is very effective
  - **Surface type (e.g., forest vs. desert)**
  - **Surface temperature**
  - **Elevation**
  - **Ice layer thickness**
- One more parameter (**beam position**) is added to further stratify the databases.
- The essential idea is to: stratify the single database into smaller but more homogenous databases. By doing so, both the surface condition and precipitation vertical structure is similar in each smaller databases.
- We have to consider the varying FOV and mixed polarization for ATMS (sounder)

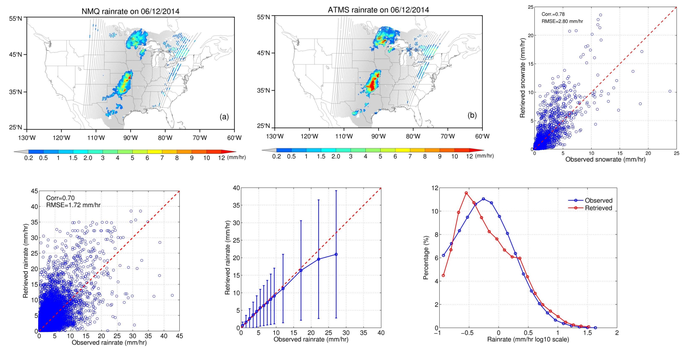
TB variation along beam position



- The TB over the edge and center of the scan line is different under clear-sky
- Separate the edge and center for database construction

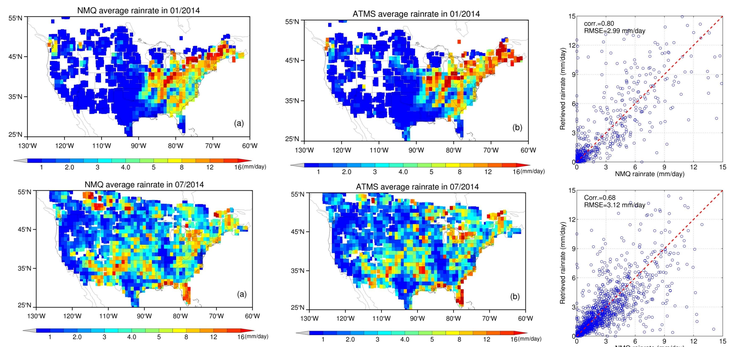
The rainfall retrieval performance

I: Case study and overall statistics



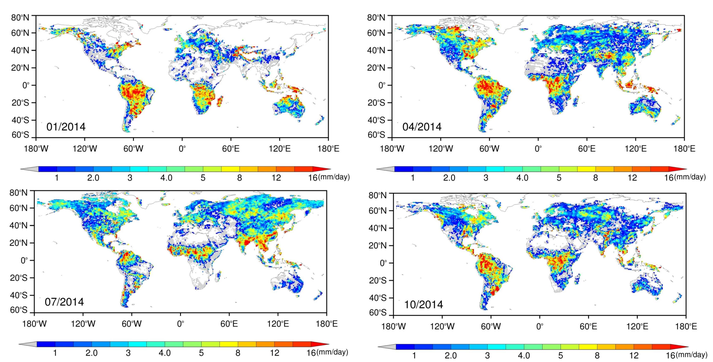
- Case study and the overall statistics show that: rainfall retrieval results agree well with the NMQ ground radar observations

II: CONUS Rainfall Seasonal Variation



- The seasonal variation of the rain pattern is well captured over the CONUS

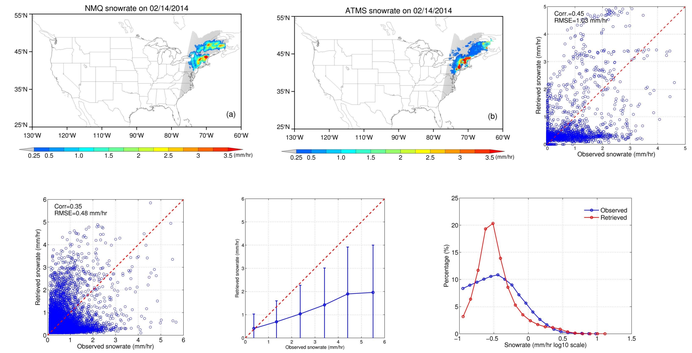
III: Global Rainfall Seasonal Variation



- Only use the CONUS data, the major rain band (e.g., ITCZ) movement is clearly demonstrated.

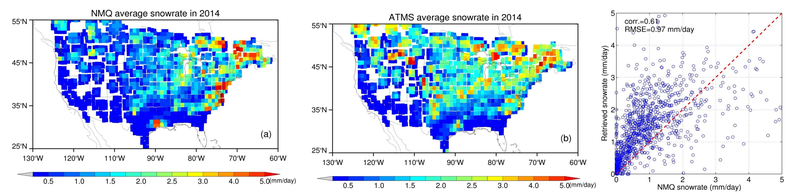
The snowfall retrieval performance

I: Case study and overall statistics



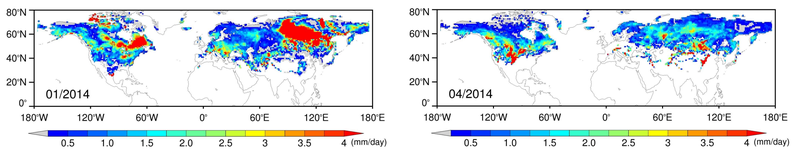
- Case study and overall statistics show that: large errors for shallow snowfall with little ice scattering signature.

II: CONUS snowfall in 2014



- NMQ and ATMS agree well over Eastern United Sates
- Large discrepancy between NMQ and ATMS over Rocky mountains. Terrain blockage accounts for the missing snowfall from NMQ ground radars over this region.

III: Seasonal variation of snowfall over Northern Hemisphere



- Only use the CONUS data, the snowfall progress and retreat in Jan. and Apr. is demonstrated
- Validation from other data sources (e.g., CloudSat and surface station observations) is needed

In summary:

- **This prototype algorithm works well for both rainfall and snowfall.**
- **The lack of scattering signature in some snowfall events and strong surface contamination make it difficult to estimate snowfall rate accurately.**
- **The ancillary parameters make it possible to "transfer" a local database to the global coverage.**
- **This algorithm has the potential to be applied for all GPM constellation radiometers, particularly the sounders.**

Reference: You, Y., N.-Y. Wang, and R. Ferraro (2015), A Prototype Precipitation Retrieval Algorithm Over Land Using Passive Microwave Observations Stratified by Surface Condition and Precipitation Vertical Structure, J. Geophys. Res. Atmos., 120, DOI: 10.1002/2014JD022534